

Four new obligate seeder taxa of *Eucalyptus* series *Rufispermae* (Myrtaceae) from the transitional rainfall zone of south-western Australia

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Abstract

Nicolle, D. Four new obligate seeder taxa of *Eucalyptus* series *Rufispermae* (Myrtaceae) from the transitional rainfall zone of south-western Australia. *Nuytsia* 19(1): 77–97 (2009). Three new species are described, viz. *E. vittata* D.Nicolle, an obligate seeder previously confused with the respouter species *E. sheathiana* Maiden and also differing from the latter in the narrower adult leaves and smaller buds and fruits; *E. frenchiana* D.Nicolle, an obligate seeder from between Norseman and Hyden, previously confused with *E. corrugata* Luehm. but most closely related to *E. pterocarpa* C.A.Gardner ex P.J.Lang and differing from the latter in the smaller leaves, buds and fruits and the hemispherical opercula; and *E. distuberosa* D.Nicolle, an obligate seeder previously confused with the respouter species *E. pileata* Blakely. Two subspecies are recognized in *E. distuberosa*, viz. subsp. *distuberosa*, of widespread but scattered distribution in the southern goldfields, and subsp. *aerata* D.Nicolle, restricted to Bronzite Ridge west of Norseman. A key to the obligate seeder taxa of *E. ser. Rufispermae* Maiden is provided.

Introduction

Eucalyptus ser. *Rufispermae* is a large series of approximately 35 species distributed almost exclusively below the Tropic of Capricorn in low to moderate rainfall areas. Only *E. repullulans* Nicolle extends north of 23° 30' S, in the Pilbara region of Western Australia. The series is well represented in the agricultural wheatbelt areas of Western Australia and South Australia, western Victoria and south-western New South Wales. The series has possibly more taxa than any other series in the genus, perhaps exceeded only by *E. ser. Subulatae* Blakely (37 terminal taxa, Nicolle 2005; Nicolle *et. al* 2005; Nicolle & Whalen 2006), which is also a series of mainly mallee species with a similar, largely southern Australian distribution. A number of new taxa have been described from *E. ser. Rufispermae* over the last two decades as a result of ongoing field collections and understanding of the patterns of variation in the series (Lang & Brooker 1990; Brooker & Hopper 1993; Nicolle 1997; Nicolle 2000b; Hill *et al.* 2001; Brooker & Slee 2005).

Eucalyptus ser. *Rufispermae* is distinguished immediately from other series in *E. sect. Dumaria* L.D.Pryor & L.A.S.Johnson ex Brooker by the seeds, which have a glossy and reddish-coloured seed coat in comparison to the duller, black, pale grey to grey, yellow-grey or brown seeds of other series in the section. The classification and other distinguishing characteristics of *E. ser. Rufispermae* within the genus are as follows (amended from Brooker 2000): *E. subg. Symphyomyrtus* (Schauer)

Brooker – cotyledons folded in seeds; buds bi-operculate; seeds with ventral or terminal hilum; seed coat formed from both integuments; *E. sect. Dumaria* – cotyledons reniform; inflorescences axillary; stamens inflexed and all fertile; anthers versatile and opening by vertical slits; *E. ser. Rufispermae* – pith of branchlets with oil glands; seeds glossy and reddish.

A group of 17 species within *E. ser. Rufispermae*, all from southern Western Australia, are obligate seeders distinguished from the remainder of *E. ser. Rufispermae* by the absence of a lignotuber, the tree (or mallet) habit, and the inability to regenerate vegetatively following wildfire. The ecological relevance and taxonomic implications of closely related resprouter - obligate seeder taxon pairs have been highlighted by Nicolle (2006). A population-based genetic study of two tree subspecies (combination sprouters using the terminology of Nicolle 2006) and two mallee subspecies (lignotuber sprouters) within *E. loxophleba* using nuclear RFLP data (Hines & Byrne 2001), indicates some genetic distinction of the tree populations from the mallee populations, although this pattern was not always consistent (both the UPGMA genetic distance analysis and the continuous character maximum likelihood analysis indicating the two groups to be paraphyletic and not monophyletic) and had a low level of confidence support. Although the Hines & Byrne (2001) study indicates some genetic basis for different regenerative strategies within *E. loxophleba* (trees/combination sprouters vs mallee/lignotuber sprouters), it may be expected that the genetic distinction between obligate seeders and resprouter eucalypt taxa (rather than different strategies within resprouter taxa) should be more pronounced. Interestingly, but not surprisingly, a similar study on the same taxa using analysis of chloroplast DNA RFLP data (Byrne & Hines 2004) indicated no distinction between the different regenerative strategies within *E. loxophleba* (and no distinction between the taxa included in the study, instead indicating a biogeographical basis of variation). The use of chloroplast DNA in eucalypts is complicated by the sharing of haplotypes among species, as demonstrated in a number of studies, including an unpublished study including resprouter and obligate seeder species within *E. ser. Subulatae*, which likewise indicated no distinction between regeneration strategies nor between taxa within the series (Nicolle & Byrne unpublished).

There are no published population-based genetic studies which include both obligate seeder and resprouter species, and so the question of whether populations with differing regenerative strategies comprise distinct phylogenetic lineages (i.e. taxa) or are ecotypic variants remains unclear. However, extensive cultivation trials of numerous obligate seeder eucalypt taxa do indicate that lignotuber development and regenerative strategy is genetically rather than environmentally determined in many taxa, including the four new taxa described here. A taxon-based phylogenetic study of *E. ser. Subulatae* and related taxa based on morphological data (Nicolle *et. al* 2006) included a number of obligate seeder species among mainly resprouter species; however, as the study was taxon-based rather than population-based, the phylogeny of resprouter - obligate seeder taxon pairs could not be ascertained. The recognition of new taxa based partly or wholly on regenerative strategy probably began with Carr and Carr (1980) and has been increasingly used as a discriminating characteristic (or set of characters) for eucalypt taxa since that time (Nicolle & Conran 1999; Nicolle 2000a; Brooker & Hopper 1991 & 2002; Nicolle & Brooker 2005).

Two of the new taxa described here (*E. vittata* and *E. distuberosa*) are relatively widespread species for which many herbarium collections have been made, but which have long remained unrecognized due to their similarity in vegetative and reproductive morphology to the mallee species *E. sheathiana* and *E. pileata* respectively. *Eucalyptus vittata* and *E. distuberosa* were identified as potential new taxa following recognition of the importance of the presence/absence of a lignotuber and its implication in plant regeneration strategy, followed by extensive field observations and cultivation of these taxa under uniform conditions at Currency Creek Arboretum in South Australia. The other two taxa described

here (*E. frenchiana* and *E. distuberosa* subsp. *aerata*) are of more restricted distribution, with their recognition largely delayed due to the past paucity of herbarium specimens, related to the relative inaccessibility of the area in which they occur. The realignment of the Hyden to Norseman road in the late 1990s led to the discovery of *E. distuberosa* subsp. *aerata* and further populations of *E. frenchiana* and the related *E. pterocarpa*. Although the absence of a lignotuber and the obligate seeder regeneration strategy is an important diagnostic characteristic in each of the four new taxa described here, each can also be distinguished from related taxa (with varying certainty) using morphological characteristics from the field and herbarium specimens alone. Of the four taxa newly described here, *E. frenchiana* is the most distinctive using morphological characteristics present in herbarium material alone, while *E. vittata* and *E. distuberosa* subsp. *aerata* can also be identified in most cases using only herbarium material. *Eucalyptus distuberosa* subsp. *distuberosa* is easily mistaken for *E. pileata* in herbaria, although there appears to be some, but possibly weak and overlapping, vegetative and reproductive morphological differences between the two species, although this is confounded by morphological variation in *E. pileata*.

Methods

All specimens of the newly described taxa and related or otherwise superficially similar taxa (including *E. assimilans* L.A.S. Johnson & K.D. Hill, *E. corrugata*, *E. pileata*, *E. pterocarpa*, *E. sheathiana* and *E. tenuis* Brooker & Hopper) incorporated in the collections at PERTH and AD have been examined, including type material. Digitised images of type specimens from NSW have also been examined. Descriptive data for new taxa have been taken from dried herbarium specimens where available (i.e. leaf, floral and fruit characteristics). For the new taxa *E. vittata*, *E. distuberosa* subsp. *distuberosa* and *E. frenchiana*, only selected specimens from a larger collection of specimens have been listed here, with specimens preferentially chosen to cover the geographical range and morphological variation within these taxa, and with duplicate specimens in multiple Australian herbaria where available. All specimens examined of *E. distuberosa* subsp. *aerata* have been listed.

Extensive field observations of wild populations of the new taxa and related taxa have been made over the last 16 years, including over 30 separate field trips (c. 180 field days) dedicated to collecting eucalypt taxa throughout south-western W.A., in addition to numerous other field trips examining related eucalypt taxa from elsewhere in Australia. All newly described and related taxa have been examined and collected in the field, often with an accompanying seed collection (see below). Field studies of wild populations over a number of years have permitted the observation of habit and bark characteristics, habitat preferences, and life histories of taxa following events such as wildfire. Descriptive data for the new taxa include field-recorded characteristics including habit and bark characteristics, leaf orientation, colour and sheen, inflorescence orientation and flower colour.

Multiple populations of the newly described taxa and related taxa have been grown under uniform conditions at Currency Creek Arboretum in S.A. (Nicolle 2003) for a number of years, with at least some populations of all the new taxa having reached maturity (flowered) in the arboretum. All plants growing at the arboretum have been grown from seed collected from wild population with accompanying voucher herbarium specimens. Descriptive data for the new taxa include seedling characteristics obtained from cultivated plants. Seedling morphology is not particularly discriminatory for taxa within *E. ser. Rufispermae*, nor of taxa within *E. sect. Dumaria* more generally, and this contrasts with most other taxa of *E. subg. Symphyomyrtus*, where seedling morphology is very often important or useful in discriminating taxa. Ongoing observations of cultivated plants have enabled the study of developmental morphology in the taxa, including leaf ontogeny related to plant maturity,

and inflorescence development. Perhaps most importantly, long-term cultivation of the new taxa have strongly indicated that the lack of a lignotuber and the obligate seeder regeneration strategy of these taxa (as well as many other obligate seeders in the genus) is genetically rather than environmentally determined.

Key to the obligate seeder taxa of *E. ser. Rufispermae*

1. Bark rough on trunk
2. Branchlets pruinose
 3. Bark rough on trunk and branches; fruit \pm smooth ***E. striatocalyx***¹
 - 3: Bark rough on trunk only (blackbutt), branches smooth; fruit \pm ribbed
 4. Adult leaves dull, grey-green..... ***E. clelandii***
 - 4: Adult leaves maturing glossy, green..... ***E. lesouefii***
- 2: Branchlets not pruinose
 5. Fruit \leq 5 mm in diameter..... ***E. kondininensis***²
 - 5: Fruit $>$ 5 mm in diameter
 6. Pedicels absent or to 2 mm long in bud..... ***E. fraseri* subsp. *melanobasis***
 - 6: Pedicels $>$ 2 mm long in bud ***E. striatocalyx***
- 1: Bark smooth throughout
 7. Inflorescences 3-flowered
 8. Opercula conical to beaked, apiculate..... ***E. pterocarpa***
 - 8: Opercula rounded to flattened
 9. Fruit cupular, distinctly corrugated/ribbed **3. *E. frenchiana***
 - 9: Fruit obconical, with a few ribs only ***E. tenuis***
 - 7: Inflorescences predominantly 7 or more-flowered
 10. Branchlets waxy
 11. Flowers bright yellow; opercula beaked..... ***E. woodwardii***
 - 11: Flowers creamy-white; opercula hemispherical
 12. Adult leaves becoming glossy with age ***E. georgei* subsp. *fulgida***
 - 12: Adult leaves dull throughout life cycle
 13. Fruits $>$ 12 mm long ***E. georgei* subsp. *georgei***
 - 13: Fruits \leq 12 mm long
 14. Fruit $>$ 8 mm in diameter; leaves 20–40 mm wide ***E. assimilans***
 - 14: Fruit $<$ 8 mm in diameter; leaves 15–22 mm wide **1. *E. vittata***
 - 10: Branchlets not waxy
 15. Leaves dull, blue-green..... **1. *E. vittata***
 - 15: Leaves glossy, green
 16. Opercula rounded to hemispherical
 17. Fruit \pm smooth, obconical to cupular..... **2a. *E. distuberosa* subsp. *distuberosa***
 - 17: Fruit distinctly ribbed, cupular..... **2b. *E. distuberosa* subsp. *aerata***
 - 16: Opercula conical to beaked
 18. Fruit $<$ 6 mm in diameter

¹ The regenerative strategy of *E. striatocalyx* W.V.Fitzg. *sens. strict.* (i.e. excluding *E. gypsophila* D.Nicolle) is poorly known. While the species usually develops a tree habit, the presence of a lignotuber in the species, and its response to wildfire, is not known.

² The generally accepted concept of *E. kondininensis* Maiden & Blakely (Brooker & Kleinig 1990; Brooker *et. al* 2002) appears to be dimorphic in respect to regenerative strategy. The centrally-distributed core area of the species, occurring mainly on subdued topography around salt lakes, and including the type locality of Kondinin, appear to be lignotuberous trees or more rarely mallees, while populations occurring on higher ground peripheral to this (e.g. Cargannocking Hill, Karlgarin Hill, Hatter Hill) are mainly non-lignotuberous mallets (obligate seeders). These non-lignotuberous populations, while very similar to typical *E. kondininensis* in bark, vegetative and reproductive morphology, may be closer to the obligate seeder species *E. polita* Brooker & Hopper; however further research is necessary to clarify the status of these species.

19. Buds and fruit \pm sessile; opercula conical..... *E. polita*
 19: Buds and fruits pedicellate; opercula shortly beaked..... *E. spreta*
 18: Fruit >6 mm in diameter
 20. Peduncles <5 mm long; pedicels absent..... *E. valens*
 20: Peduncles 2–13 mm long; pedicels 0–5 mm long..... *E. fraseri* subsp. *fraseri*

Two obligate seeder species described recently by Hill *et al.* (2001) are not recognised as distinct here. These are *E. paralimnetica* L.A.S.Johnson & K.D.Hill, which I cannot distinguish from *E. spreta* L.A.S.Johnson & K.D.Hill using morphology from field observations, herbarium specimens and cultivated seedlings, and *E. redimulculifera* L.A.S.Johnson & K.D.Hill which I consider to represent an intergrading population or hybrid swarm between *E. vittata* and *E. spreta* (see *Notes* under *E. vittata*).

Taxonomy

1. *Eucalyptus vittata* D.Nicolle, *sp. nov.*

Affinis *Eucalypto sheathianae* Maiden sed habitu arborescenti (forma ‘mallet’), absentia lignotuberis, foliis adultis angustioribusque et alabastris fructibusque plerumque parvioribus differt.

Typus: breakaways c. 55 km east of Southern Cross – Forrestania road on Hyden – Norseman road, Western Australia, 32° 16' 54" S, 120° 15' 55" E, 16 July 2001, D. Nicolle 3830 & M.E. French (*holo*: PERTH 07219601; *iso*: CANB).

Eucalyptus sp. Southern Goldfields (D. Nicolle & M. French DN 3652); *Eucalyptus dendrosheath* D.Nicolle ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, <http://www.chah.gov.au/apc/index.html> [accessed 1 January 2009].

Distinguished within the series by its combination of obligate seeder regenerative strategy; absence of a lignotuber; completely smooth bark; waxy branchlets; dull, blue-green leaves; 7-flowered inflorescences; variably waxy, \pm smooth buds with a rounded operculum and variably waxy, \pm smooth, cupular fruits.

Mallet 6–14 m tall; lignotuber absent (obligate seeder). *Bark* smooth throughout, grey to light yellow-grey over pale salmon-cream to white, decorticating in long ribbons which are seasonally conspicuous. *Branchlets* waxy, with pith glands. *Seedling leaves* petiolate, ovate, slightly discolorous, slightly glossy, green to slightly blue-green, the new growth slightly waxy; seedling stems slightly angular to square, moderately glandular. *Adult leaves* petiolate; lamina narrow-lanceolate to lanceolate and slightly falcate, 70–130 mm long \times 8–17 mm wide, dull, blue-green; vein reticulation moderate to dense with scattered island and intersectional oil glands. *Inflorescences* axillary, unbranched, 7-flowered; peduncles terete to slightly angular, 8–13 mm long; pedicels terete, 3–6 mm long. *Flower buds* pedicellate, often waxy, 9–11 mm long \times 4–6 mm wide; hypanthia cupular, generally smooth; opercula conical to pileate, smooth or slightly longitudinally ribbed (ribs less than 1 mm deep). *Flowers* white. *Fruits* pedicellate, often waxy, cupular to barrel-shaped to slightly campanulate, 6–7 mm long \times 5–7 mm wide; disc slightly descending to descending; valves 4, enclosed or to rim level. *Seeds* flattened-angular, glossy and reddish-brown. (Figures 1, 2)



Figure 1. Holotype of *Eucalyptus vittata* (D. Nicolle 3830 & M.E. French), scale = 5 cm..



Figure 2. *Eucalyptus vittata* habit—crossroads of Holland Track and Lake Johnston—Coolgardie road, 12 Sep. 2004, D. Nicolle 4754 (CANB, PERTH).

Selected specimens examined: WESTERNAUSTRALIA: 22.4 miles N of Bullfinch towards Die Hardy Range, 11 Feb. 1970, M.I.H. Brooker 2442 (AD, PERTH); 57 km W of Coolgardie towards Southern Cross, 6 Apr. 1977, M.I.H. Brooker 5664 (AD, CANB, PERTH); 63 km from Norseman towards Balladonia, 2 Sep. 1998, M.I.H. Brooker 12928 & A.V. Slee (CANB, PERTH); E of Elachbutting Hill, 10 Apr. 1998, M.E. French 430 (PERTH); 20.8 km W of Norseman—Coolgardie road on track to Hyden, 7 Nov. 1983, K. Hill 604, L. Johnson, D. Blaxell, M.I.H. Brooker & S.D. Hopper (NSW, PERTH); 68 km E of Norseman on Highway 1, 14 Nov. 1983, K. Hill 695 & D. Blaxell (NSW, PERTH); 88.8 km E of Norseman on highway, 4 Nov. 1986, K. Hill 2214 & L.A.S. Johnson (NSW, PERTH); 13.4 km from Yellowdine towards Boorabin on Great Eastern Hwy, 1 Oct. 2000, D. Nicolle 3474 & M.E. French (CANB, PERTH); N of Lake Deborah West on vermin proof fence, 1 Oct. 2000, D. Nicolle 3484 & M.E. French (CANB, PERTH); E of Bronzite Ridge on the new Hyden to Norseman road, 10 Nov. 2000, D. Nicolle 3652 & M.E. French (CANB, PERTH); 7.2 km S of Lake Cronin crossroads towards South Ironcap, 10 Nov. 2000, D. Nicolle 3667 & M.E. French (CANB, PERTH); 31.1 km S of Dundas Nature Reserve boundary gate with Southern Hills Station on the Fraser Range—Mt Ridley track, 18 July 2001, D. Nicolle 3876 & M.E. French (CANB, PERTH); cross roads of Holland Track and Lake Johnston—Coolgardie road, 12 Sep. 2004, D. Nicolle 4754 (CANB, PERTH).

Distribution and habitat. *Eucalyptus vittata* is relatively widespread and common on the north-eastern margin of the wheatbelt in Western Australia, where it is distributed from the Hamersley Lakes area in the north-west, south to the Varley area and eastwards to the Fraser Range (Figure 3). The

species occurs on pale red to pale brown sandy loams to clay loams, often on flats around dry salt lakes and clay pans or on runoff flats below low breakaways. *Eucalyptus vittata* sometimes occurs in more or less pure, even-aged mallee stands with few understorey species, or in mixed mallee-mallet woodland vegetation. Associated eucalypt species include *E. alipes*, *E. celastroides* subsp. *virella*, *E. cylindrocarpa*, *E. eremophila*, *E. exigua*, *E. horistes*, *E. kochii* subsp. *yellowdinensis*, *E. laevis*, *E. melanoxylon*, *E. moderata*, *E. myriadena*, *E. prolixa*, *E. salicola*, *E. salmonophloia*, *E. salubris*, *E. tenera*, *E. transcontinentalis*, *E. urna* and *E. yilgarnensis*.

Conservation status. *Eucalyptus vittata* is of scattered occurrence over a relatively wide area and is not considered to be at risk. Recorded from Dundas Conservation Reserve.

Etymology. From the Latin *vittatus* (decorated or bound with a ribbon), referring to the smooth bark which is seasonally decorticated to become conspicuous as long ribbons hanging in the crown.

Notes. *Eucalyptus vittata* has long been included in *E. sheathiana*, from which the former differs most notably in the non-lignotuberous, mallet habit (Figure 2). *Eucalyptus sheathiana* is consistently a lignotuberous mallee (Figure 4) and the distributions of the two species do not appear to overlap, with *E. sheathiana* having a more westerly distribution between about Mukinbudin and Newdegate (Figure 3). The adult leaves of *E. vittata* also tend to be narrower and the buds and fruits smaller than in *E. sheathiana*, enabling herbarium specimens to be distinguished.

Eucalyptus vittata is perhaps most closely related to *E. assimilans*, differing from the latter in the smaller and narrower adult leaves and the smaller buds and fruits. *Eucalyptus assimilans* occurs to the east of the Fraser Range (Figure 2). The related *E. georgei* Brooker & Blaxell, which occurs within the distribution of *E. vittata* in the Bremer Range to Lake Johnston area (but is ecologically separated, with *E. georgei* generally occurring on higher, more undulating topography), also has larger and broader adult leaves and larger buds and fruits than *E. vittata*.

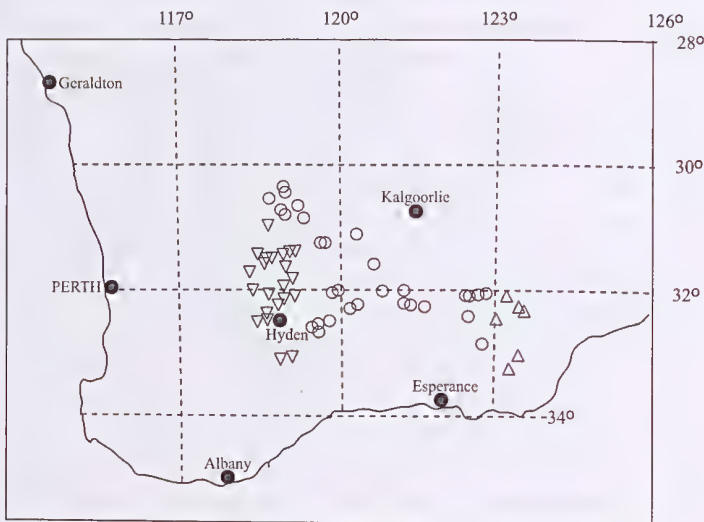


Figure 3. Distribution of *Eucalyptus sheathiana* (▽), *E. vittata* (○) and *E. assimilans* (△) in south-west Western Australia.



Figure 4. *Eucalyptus sheathiana* habit – Ivey Road, south of Bodallin, 21 Sep. 2004, D. Nicolle 4787 & M.E. French (PERTH).

Eucalyptus vittata appears to intergrade with the more distantly related *E. kondininensis* Maiden & Blakely over a small distance in the Lake Varley area (see Appendix), with intergrade individuals conspicuous in the field due to their intermediate bark characteristics (*E. kondininensis* has rough, dark bark on the trunk and primary branches). An intergrading population between *E. vittata* and *E. spreata* is known north-west of Norseman, with the type of *E. redimiculifera* representing this intergrade (see Appendix).

2. *Eucalyptus distuberosa* D.Nicolle, *sp. nov.*

Affinis *Eucalypto piliatae* Blakely sed habitu arborescenti (forma ‘mallet’), absentia lignotuberis differt.

Typus: north-east of Yellowdine on vermin proof fence, Western Australia, 31° 09' 53" S, 119° 50' 19" E, 1 October 2000, D. Nicolle 3480 & M.E. French (*holo*: PERTH 05789206; *iso*: CANB).

Eucalyptus sp. Southern Cross (D. Nicolle & M. French DN 3480); *Eucalyptus distuberosa* D.Nicolle ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, <http://www.chah.gov.au/apc/index.html> [accessed 1 January 2009].

Distinguished within the series by its combination of obligate seeder regenerative strategy; absence of a lignotuber; completely smooth bark; lack of wax on all parts; glossy, green leaves; 7-flowered inflorescences; buds with a rounded operculum and cupular fruits.

Mallet 5–14 m tall; lignotuber absent (obligate seeder). *Bark* smooth throughout, dark grey to tan over orange-tan to creamy-white, decorticating in long ribbons which are often seasonally conspicuous.

Branchlets not waxy, with pith glands. *Seedling leaves* petiolate, ovate, slightly discolorous, more or less glossy, green to slightly blue-green, the new growth sometimes slightly waxy; seedling stems slightly angular to square, moderately glandular. *Adult leaves* petiolate; lamina lanceolate, 60–120 mm long \times 8–22 mm wide, glossy, dark green; vein reticulation moderate to dense; oil glands moderately dense, island and intersectional. *Inflorescences* axillary, unbranched, predominantly 7-flowered; peduncles terete to slightly angular, 5–13 mm long; pedicels terete, 3–6 mm long. *Flower buds* not waxy, 7–10 mm long \times 4.5–7 mm wide; hypanthia cupular; opercula equal to or slightly wider than hypanthia, hemispherical to pileate. *Flowers* white. *Fruits* pedicellate, not waxy, smooth to prominently ribbed, cupular to slightly campanulate or obconical, 5–8 mm long \times 6–8 mm wide; disc level to descending; valves 3 or 4, around rim level. *Seeds* flattened-angular, glossy and reddish-brown.

Etymology. From the Latin *dis* (without; not) and *tuberosus* (full of lumps or protuberances), referring to the absence of a lignotuber in this species, which distinguishes it from the closely related, lignotuberous *E. pileata*.

Notes. *Eucalyptus distuberosa* has long been included in *E. pileata* Blakely (Figure 5), from which it consistently differs in the non-lignotuberous, mallee habit. Brooker & Kleinig (1990) illustrate *E. distuberosa* as the habit photo of *E. pileata* in their treatment of the eucalypts of south-Western Australia. *Eucalyptus pileata* is a lignotuberous mallee with a more widespread distribution than *E. distuberosa*, extending south to the Ravenhorpe area and west to the Lake Grace area. The distribution of the two species significantly overlap; however they are not known to be associated, with *E. distuberosa* occurring on heavy soils in woodland-dominated vegetation and *E. pileata* occurring on yellow sands in open mallee scrub where their distributions overlap.

More recently, *E. distuberosa* has also been confused with *E. tenuis*, both of which share the non-lignotuberous mallee habit. *Eucalyptus distuberosa* is distinguished from *E. tenuis* by the predominantly seven-flowered inflorescences (consistently three-flowered in *E. tenuis*), the generally shorter pedicels (to 20 mm long in *E. tenuis*) and the more cupular fruits (obconical fruits in *E. tenuis*). The distribution of the two species largely overlaps south-west of Coolgardie in the Hyden scrub, and intergrades between the two species are known (see Appendix).

Two subspecies are recognized in *E. distuberosa*, differing primarily in flower bud and fruit ornamentation.

2a. *Eucalyptus distuberosa* D.Nicolle subsp. *distuberosa*

Distinguished within the series by its combination of obligate seeder regenerative strategy; absence of a lignotuber; completely smooth bark; lack of wax on all parts; glossy, green leaves; 7-flowered inflorescences; \pm smooth buds with a rounded operculum and \pm smooth, cupular fruits.

Distinguished from subsp. *aerata* by the smooth or faintly ribbed flower buds (including opercula) and fruits.

Adult leaves 70–120 mm long \times 10–22 mm wide. *Flower buds* 7–9 mm long \times 5–7 mm wide; hypanthia smooth or shallowly ribbed; opercula usually slightly wider than hypanthia, shallowly ribbed (ribs less than 1 mm deep). *Fruits* cupular to slightly campanulate, smooth to faintly striate, 6–8 mm long \times 6–8 mm wide; valves usually 4. (Figures 6, 7)



Figure 5. *Eucalyptus pileata* habit – Lake Johnston–Coolgardie road, 12 Sep. 2004, D. Nicolle 4752 (CANB, PERTH).

Selected specimens examined. WESTERNAUSTRALIA: 88 km W of Bullabulling, 20 Aug. 1979, *M.I.H. Brooker* 6394 (PERTH); E of Banker Mount Day Track on Holland Track, 17 Apr. 2003, *M.E. French* 1528 (PERTH); N of Great Eastern Highway, E of Karalee Rocks, 20 Apr. 2003, *M.E. French* 1545 (PERTH); N of Great Eastern Highway, W of Karalee Rock, 20 Apr. 2003, *M.E. French* 1548 (PERTH); on Trans Australia railway road between Jaurdi and Wallaroo sidings, W of Coolgardie, 7 Dec. 2003, *M.E. French* 1568 (PERTH); E from Yellowdine, 3 Nov. 1965, *C.A. Gardner* 16302 (PERTH); 74.2 km of Yellowdine on highway, Coolgardie subdivision, 26 Nov. 1986, *K. Hill* 2628 & *L.A.S. Johnson* (NSW, PERTH); c. 83 km E of Coolgardie turnoff on the new Hyden to Norseman road, 16 July 2001, *D. Nicolle* 3846 & *M.E. French* (AD, CANB, PERTH).

Distribution and habitat. The distribution of *E. distuberosa* subsp. *distuberosa* is imperfectly known, but appears to have a scattered distribution in the scrub of Western Australia's central and southern goldfields, from Jaurdi area in the north, southwards towards Norseman. (Figure 8). The subspecies occurs on more or less level topography or on slight rises of pale orange to red-brown sandy loams to clay loams, often in small, even-aged, pure stands or in mixed mallee-mallet woodland. Associated eucalypts include *E. kochii*, *E. loxophleba* subsp. *lissophloia*, *E. moderata*, *E. oleosa*, *E. salmonophloia*, *E. subangusta* subsp. *subangusta*, *E. tenera*, *E. tortilis*, *E. urna* and *E. yilgarnensis*.

Conservation status. *Eucalyptus distuberosa* is of very scattered distribution but is moderately widespread and is not considered to be at risk. The species has not been recorded from a conservation reserve.



Figure 6. Holotype of *Eucalyptus distuberosa* subsp. *distuberosa* (D. Nicolle 3480 & M.E. French), scale = 5 cm.



Figure 7. *Eucalyptus distuberosa* subsp. *distuberosa* habit—Great Eastern Highway between Southern Cross and Coolgardie, 11 Aug. 2003, D. Nicolle 4616 (AD, PERTH). Note that these plants are closely-spaced single-stemmed trees (mallets) and not multi-stemmed mallees.

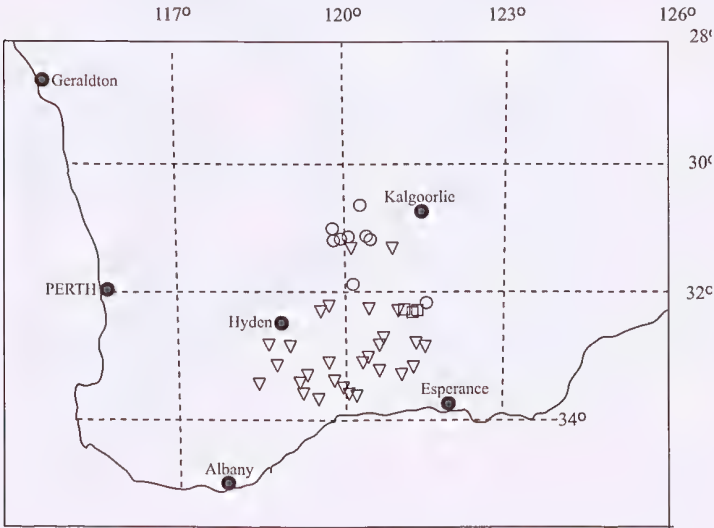


Figure 8. Distribution of *Eucalyptus pileata* (▽), *E. distuberosa* subsp. *distuberosa* (○) and *E. distuberosa* subsp. *aerata* (◻) in south-west Western Australia.

Notes. Distinguished from the much more restricted *E. distuberosa* subsp. *aerata* in the smooth or faintly ribbed buds and fruit. Intergrades between the two subspecies are known (see Appendix).

2b. *Eucalyptus distuberosa* D.Nicolle subsp. *aerata* D.Nicolle, subsp. nov.

A subspecies typica alabastris fructibusque prominenter costatis differt.

Typus: Hyden to Norseman road, Western Australia, [precise locality withheld for conservation reasons], 10 November 2000, *D. Nicolle* 3653 & *M.E. French* (*holo:* PERTH 05782902; *iso:* AD, CANB)

Eucalyptus sp. Bronzite Ridge (D. Nicolle & M. French DN 3653); *Eucalyptus aerisica* D.Nicolle ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, <http://www.chah.gov.au/apc/index.html> [accessed 1 Jan. 2009].

Distinguished within the series by its combination of obligate seeder, non-lignotuberous habit; completely smooth bark; lack of pruinosity; glossy, green leaves; 7-flowered inflorescences; prominently ribbed buds with a rounded operculum and prominently ribbed, cupular fruits.

Distinguished from *E. distuberosa* subsp. *distuberosa* in the prominently ribbed buds and fruit.

Adult leaves 60–90 mm long × 8–12 mm wide. *Flower buds* 8–10 mm long × 4.5–6 mm wide; hypanthia prominently ribbed (ribs *c.* 1 mm deep); opercula equal to or slightly wider than hypanthia, prominently ribbed (ribs *c.* 1 mm deep). *Fruits* cupular to obconical, prominently ribbed (ribs *c.* 1 mm deep), 5–7 mm long × 6–7.5 mm wide; valves 3 or 4. (Figures 9, 10)

Specimens examined. WESTERN AUSTRALIA: Bronzite Ridge on new road to Norseman, Hyden–Coolgardie Road, 16 Dec. 2000, *M.E. French* 1240 (PERTH); Hyden–Norseman Road, SE of Disappointment Rock near Bronzite Ridge, 1 Mar. 2003, *M.E. French* 1502 (PERTH); Bronzite Ridge, on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3655 & *M.E. French* (CANB, PERTH); Bronzite Ridge, on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3657 & *M.E. French* (CANB, PERTH); Bronzite Ridge, on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3658 & *M.E. French* (PERTH); Bronzite Ridge, at highest point on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3659 & *M.E. French* (PERTH); 51.6 km E of Coolgardie turnoff on the Hyden to Norseman road, 16 July 2001, *D. Nicolle* 3844 & *M.E. French* (CANB, PERTH).

Distribution and habitat. Restricted to Bronzite Ridge between Lake Johnston and Norseman (Figure 8). It often occurs in near pure, even-aged mallet stands with other obligate seeder eucalypt species, or in mixed mallee-mallet vegetation. Associated eucalypts include *E. celastroides* subsp. *celastroides*, *E. diptera* or *E. diptera* – *E. tortilis* intergrades, *E. eremophila*, *E. frenchiana*, *E. livida*, *E. oleosa* or *E. oleosa* – *E. longicornis* intergrades, *E. prolixa*, *E. pterocarpa*, *E. salmonophloia* and *E. urna*.

Conservation status. Recently listed as Priority One under the Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora (Atkins 2008). Known along a single section of the new alignment of the Hyden to Norseman road, where it is relatively common. The taxon is in need of further survey to ascertain the extent of its distribution and its conservation status.

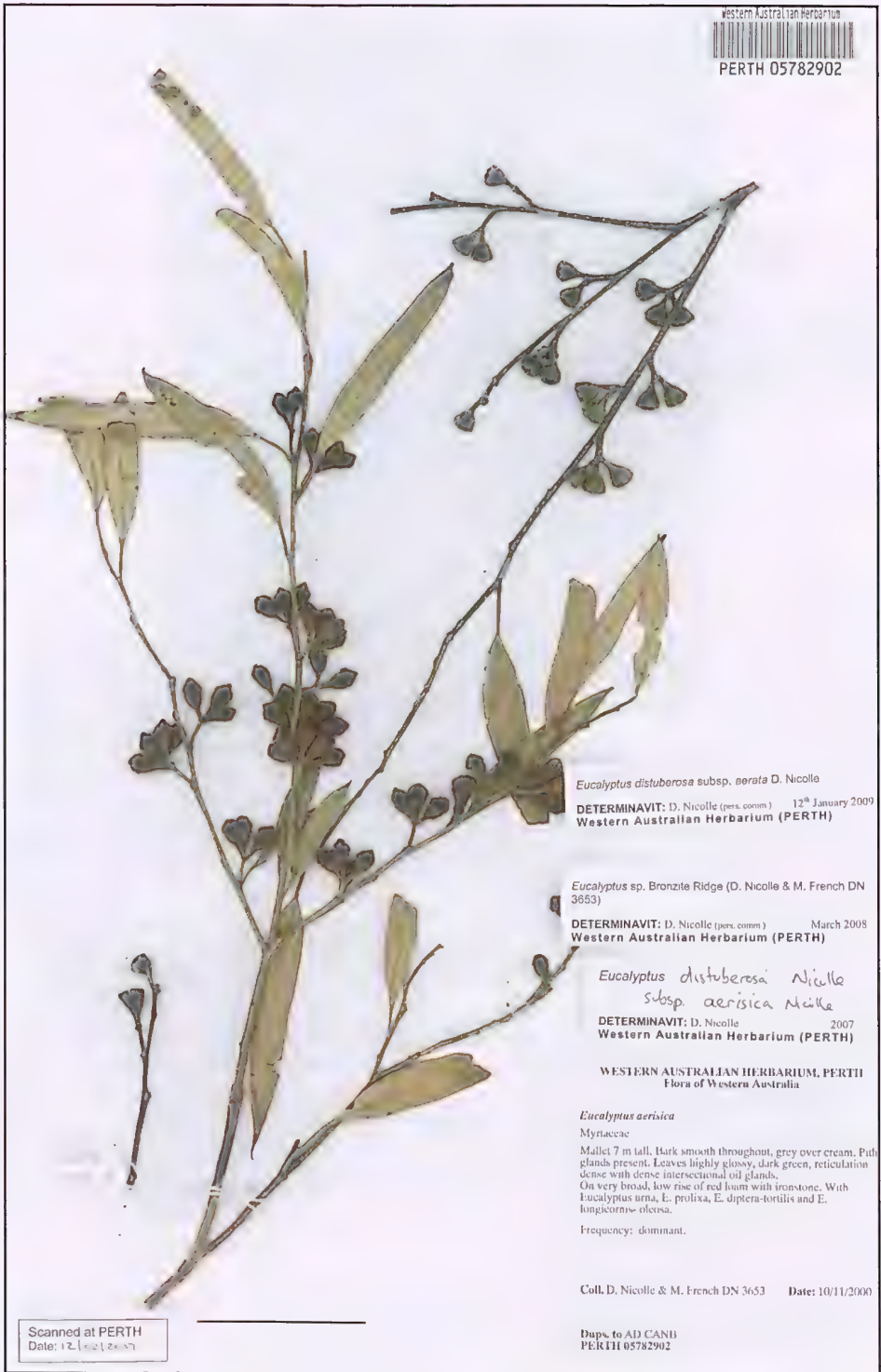


Figure 9. Holotype of *Eucalyptus distuberosa* subsp. *aerata* (D. Nicolle 3653 & M.E. French), scale = 5 cm.



Figure 10. *Eucalyptus distuberosa* subsp. *aerata* habit—Bronzite Ridge, on the new Hyden to Norseman road, 10 Nov. 2000, D. Nicolle 3653 & M.E. French (AD, CANB, PERTH).

Etymology. From the Latin *aerata* (furnished or covered with bronze), alluding to the species' discovery and apparent restriction to Bronzite Ridge, west of Norseman.

Notes. Distinguished from the more widespread *E. distuberosa* subsp. *distuberosa* in the prominently ribbed buds and fruit. Intergrades between the two subspecies are known (see Appendix).

This taxon appears to have been first collected in 2000, following the realignment of the Hyden to Norseman road over Bronzite Ridge. Initial collection of populations from Bronzite Ridge in 2000 indicated that it was probably an undescribed taxon. Subsequent collections and study of these populations indicated that although locally uniform and distinctive in bud and fruit ornamentation, the populations represented a geographical variant of another undescribed taxon (*E. distuberosa* subsp. *distuberosa*), with intergrading specimens known (see Appendix).

3. *Eucalyptus frenchiana* D.Nicolle, *sp. nov.*

Affinis *Eucalypto pterocarpae* Gardner ex Lang sed foliis adultis parvioribus, alibastris parvioribus, operculo hemispherico breviorique et fructibusque parvioribus differt.

Typus: 6.8 km west of the Coolgardie turnoff towards Hyden on the new Hyden to Norseman road, Western Australia, 32° 03' 19" S, 120° 42' 36" E, 10 November 2000, D. Nicolle 3663 & M.E. French (*holo:* PERTH 05783429; *iso:* CANB).

Eucalyptus sp. Lake Johnston (D. Nicolle & M. French DN 3663); *Eucalyptus evexa* D.Nicolle ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, <http://www.chah.gov.au/apc/index.html> [accessed 1 January 2009].

Eucalyptus obtusata D.Nicolle ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, <http://www.chah.gov.au/apc/index.html> [accessed 1 January 2009].

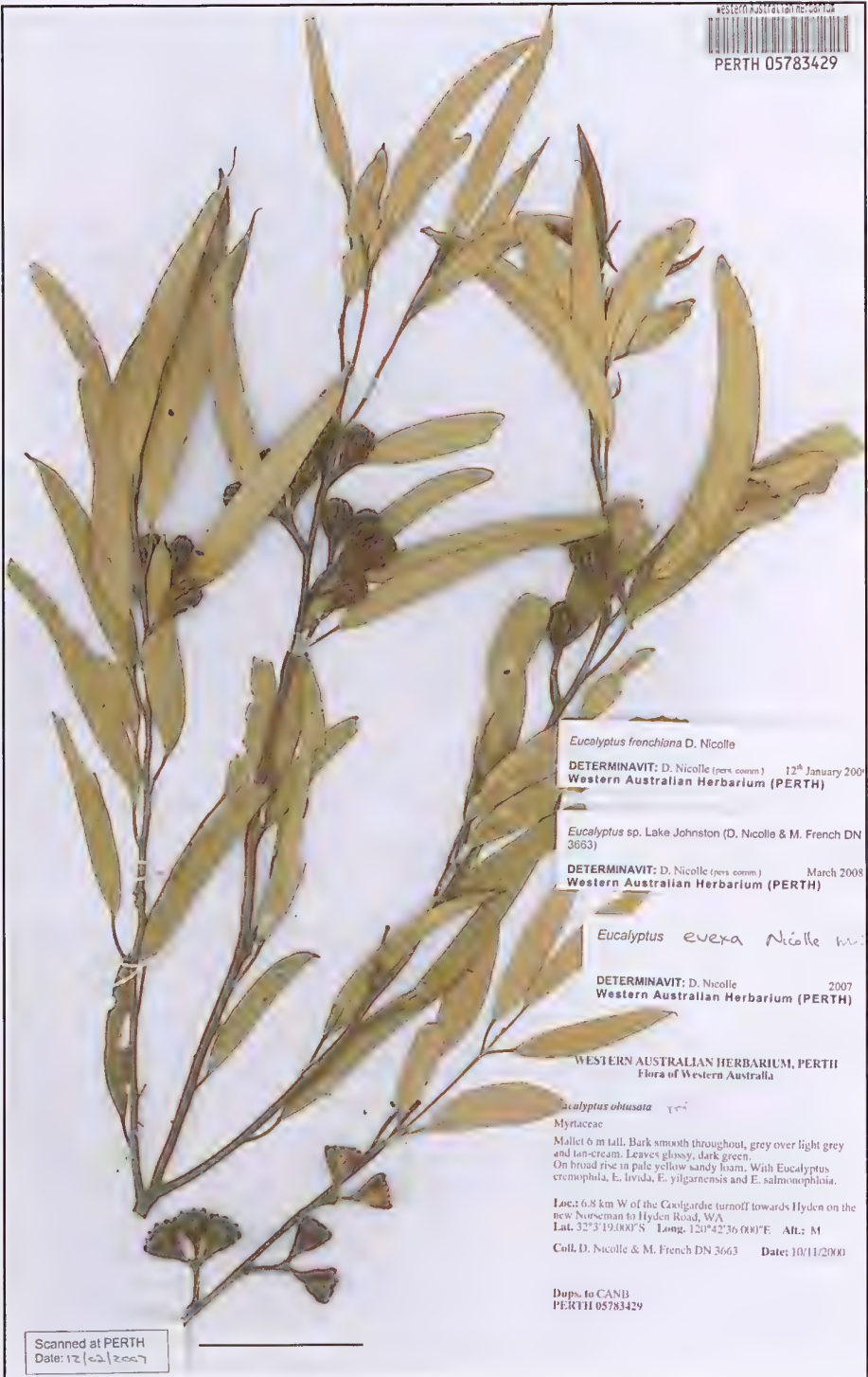
Eucalyptus pterocarpa subsp. *obtusata* Brooker ms, in Council of Heads of Australasian Herbaria, *Australian Plant Census*, <http://www.chah.gov.au/apc/index.html> [accessed 1 January 2009].

Distinguished within the series by its combination of obligate seeder, non-lignotuberous habit; completely smooth bark; lack of wax on all parts; glossy, green leaves; 3-flowered inflorescences; large, prominently ribbed buds with a rounded operculum and the large, prominently ribbed, cupular fruits.

Distinguished from *E. pterocarpa* in the smaller adult leaves, the smaller buds with a shorter, hemispherical operculum and the smaller fruits.

Mallet 6–14 m tall; lignotuber absent (obligate seeder). *Bark* smooth throughout, grey over light grey, tan or cream, decorticating in ribbons. *Branchlets* not waxy, with pith glands. *Seedling leaves* petiolate, ovate, discolorous, slightly glossy, light green to green; seedling stems slightly square, sparsely to moderately glandular. *Adult leaves* petiolate; lamina narrow-lanceolate, 55–100 mm long × 9–13 mm wide, highly glossy, green; vein reticulation moderate to dense; oil glands moderately dense, island and intersectional. *Inflorescences* axillary, unbranched, 3-flowered; peduncles angular to very slightly flattened, 8–13 mm long; pedicels angular, 5–11 mm long. *Flower buds* not waxy, 12–150 mm long × 8–12 mm wide; hypanthia cupular, prominently longitudinally ribbed; opercula hemispherical, prominently ribbed (ribs to 2.5 mm deep). *Flowers* white. *Fruits* not waxy, cupular to obconical, deeply ribbed (ribs 1–2 mm deep), 10–12 mm long × 10–13 mm wide; disc level; valves 4, around rim level. Seeds flattened-angular, glossy and reddish-brown. (Figure 11)

Selected specimens examined. WESTERN AUSTRALIA: 2–4 km on track to Scamp Rock, ESE of McDermid Rock, Hyden–Norseman Track, 16 Sep. 2002, *R. Butler* 174-51 (AD, CANB, NSW, PERTH); Disappointment Rock on Hyden–Norseman Track, 16 Sep. 2002, *R. Butler* 174-56 (PERTH); 60.5 km W of Coolgardie - Esperance Road on old Hyden - Norseman track, 12 May 2003, *J.A. Cochrane* 4622 & *A. Crawford* (PERTH); N on track 22 km E of Victoria Rock turnoff towards Norseman on Hyden track, 30 March 1997, *M.E. French* 165 (PERTH); 2–4 km on track to Scamp Rock, ESE McDermid Rock on Hyden–Norseman Track, 22 Apr. 1998, *M.E. French* 456 (PERTH); W of Mount Dermid Rock on Old Hyden–Norseman Track, 22 April 1998, *M.E. French* 465 (PERTH); 196.3 km E of Hyden near Hyden–Norseman track (probably Lake Johnston), 24 Sep. 1991, *P. Grayling* 791 (PERTH); 60.5 km W of Coolgardie–Norseman road on Hyden track, 25 Aug. 1988, *K. Hill* 2857 (PERTH); Lake Johnston, 13 May 1989, *S.D. Hopper* 7254 (PERTH); Hyden–Norseman Road, 23 km W McDermid Rock, E Bremer Range, 8 May 1978, *G.J. Keighery* 1702 (PERTH); 332 mile peg on Hyden - Norseman track [c. 195 km E of Hyden on Hyden–Norseman track, 16 Aug. 1966, *A. Kessell* 432 (PERTH); 1.5 miles E of Spinifex Rock on Hyden–Norseman track, 8 Feb. 1967, *A. Kessell* 548 (PERTH); between Hyden to Norseman road and Lake Johnston, 21 Apr. 1998, *D. Nicolle* 2286 & *M.E. French* (PERTH); between Disappointment Rock and Bronzite Ridge on the new Hyden to Norseman road, 10 Nov. 2000, *D. Nicolle* 3660 & *M.E. French* (CANB, PERTH); ‘Old’ Hyden–Norseman road, 27 km N of junction with ‘new’ road, 29 Aug. 1998, *W. O’Sullivan* 431 & *P.J. White* (PERTH).



WESTERN AUSTRALIAN HERBARIUM
 PERTH 05783429

Eucalyptus frenchiana D. Nicolle
 DETERMINAVIT: D. Nicolle (pers. comm.) 12th January 2007
 Western Australian Herbarium (PERTH)

Eucalyptus sp. Lake Johnston (D. Nicolle & M. French DN 3663)
 DETERMINAVIT: D. Nicolle (pers. comm.) March 2008
 Western Australian Herbarium (PERTH)

Eucalyptus evexa Nicolle n. sp.
 DETERMINAVIT: D. Nicolle 2007
 Western Australian Herbarium (PERTH)

WESTERN AUSTRALIAN HERBARIUM, PERTH
 Flora of Western Australia

Eucalyptus obtusata var.
 Myrtaceae
 Mallee 6 m tall. Bark smooth throughout, grey over light grey and tan-cream. Leaves glossy, dark green.
 On broad rise in pale yellow sandy loam. With *Eucalyptus crenophylla*, *E. livida*, *E. yilgarnensis* and *E. salmonophloia*.

Loc: 6.8 km W of the Caxtygahie turnoff towards Hyden on the new Norseman to Hyden Road, WA
 Lat. 32°3'19.000"S Long. 120°42'36.000"E Alt: M
 Coll. D. Nicolle & M. French DN 3663 Date: 10/11/2000

Dups. to CANB
 PERTH 05783429

Scanned at PERTH
 Date: 12/02/2007

Figure 11. Holotype of *Eucalyptus frenchiana* (D. Nicolle 3663 & M.E. French), scale = 5 cm.

Distribution and habitat. Distributed in uncleared country between Hyden and Norseman, namely in the Lake Johnston area and eastwards towards Bronzite Ridge (Figure 12). It occurs as a component of mixed mallee-mallet woodland on pale yellow to brown sandy-loam to clay soils, sometimes on broad rises. Associated eucalypts include *E. distuberosa*, *E. eremophila*, *E. livida*, *E. longicornis*, *E. loxophleba* subsp. *lissophloia*, *E. salmonophloia*, *E. urna* and *E. yilgarnensis*.

Conservation status. Occurs in largely uncleared country and not considered to be under any immediate threat. There are relatively few collections of this species and it is not known whether the paucity of collections is due to a limited and sparse distribution or to the general lack of botanical collections away from the Hyden to Norseman road in the general area.

Etymology. Named for Malcolm E. French (1947 -), an astute and enthusiastic observer and collector of eucalypts, in recognition of his significant contributions to the understanding of the eucalypts and particularly to the discovery and recognition of many new eucalypt taxa in southern Western Australia, including this new species.

Notes. *Eucalyptus frenchiana* has been confused with *E. corrugata* Luehm., of *E. ser. Corrugatae*, with which the leaves, buds and fruits are superficially similar. *Eucalyptus frenchiana* differs from *E. corrugata* in the glossy, reddish-brown and shallowly pitted seed (dull, greyish and deeply pitted in *E. corrugata*) and the complete lack of wax (branchlets usually conspicuously waxy in *E. corrugata*).

Eucalyptus frenchiana is probably most closely related to *E. pterocarpa* Gardner ex Lang, differing most conspicuously in the shorter, hemispherical operculum (longer than the hypanthium and beaked in *E. pterocarpa*) and also in the generally smaller adult leaves, buds and fruits. The two species are not known to occur in association, with *E. pterocarpa* occurring east of Bronzite Ridge to the north-west to south-west of Norseman (Figure 12).

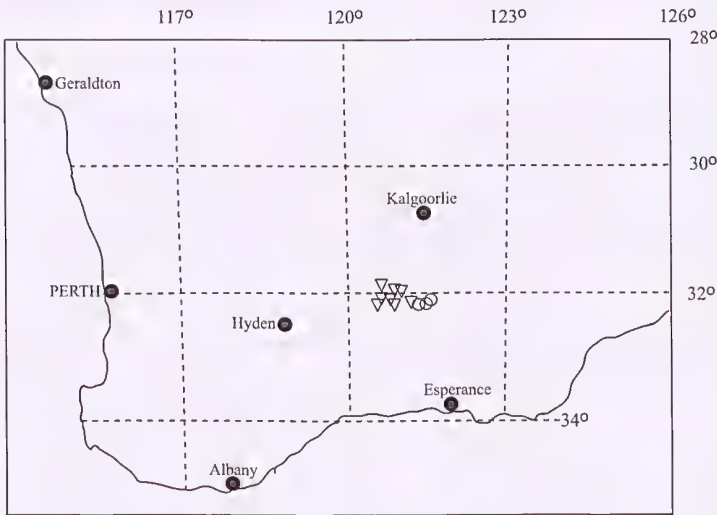


Figure 12. Distribution of *Eucalyptus frenchiana* (▽) and *E. pterocarpa* (○) in south-west Western Australia.

Acknowledgements

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Appendix

Intergrades and hybrids

***Eucalyptus distuberosa* subsp. *aerata* – subsp. *distuberosa* intergrades**

Selected specimens examined. WESTERN AUSTRALIA: 69.3 km east of Coolgardie turnoff on Hyden–Norseman road, 16 July 2001, *D. Nicolle* 3845 & *M.E. French* (CANB, PERTH).

***Eucalyptus vittata* – *E. kondininensis* intergrades**

Selected specimens examined. WESTERN AUSTRALIA: c. 2 km W of Varley, 11 Nov. 2000, *D. Nicolle* 3677 & *M.E. French* (CANB, PERTH); 1.5 km NE of Holt Rock, 15 July 2001, *D. Nicolle* 3817 & *M.E. French* (CANB, PERTH).

***Eucalyptus vittata* – *E. spreata* intergrades**

Eucalyptus redimiculifera L.A.S.Johnson & K.D.Hill, *Telopea* 9(2): 316 (2001).

Typus: 5.6 km W of Highway on track turning off 11 km N of Norseman, W.A., *K.D. Hill* 589, *L.A.S. Johnson*, *D.F. Blaxell*, *M.I.H. Brooker* & *S.D. Hopper*, 6 Nov. 1983 (*holo:* NSW; *iso:* CANB, PERTH).

Selected specimens examined. WESTERNAUSTRALIA: 5 km W from the main Norseman to Coolgardie road on the track to *Eucalyptus pterocarpa*, 6 Oct. 1993, *D. Nicolle* 551 (AD, CANB, PERTH).

***Eucalyptus distuberosa* subsp. *distuberosa* – *E. tenuis* intergrades**

Selected specimens examined. WESTERN AUSTRALIA: Holland Track, between Mt Holland and Lake Johnston – Coolgardie road, 18 Aug. 2003, *D. Nicolle* 4676 (PERTH).